

FORM PTO-1390 (REV. 12-2001)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER <b>540608-2002</b>	
<b>TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371</b>				U.S. APPLICATION NO. (If known see 37 C.F.R. 1.5) <b>10/089201</b>	
INTERNATIONAL APPLICATION NO. <b>PCT/EP00/09529</b>		INTERNATIONAL FILING DATE <b>28 SEPTEMBER 2000</b>		PRIORITY DATE CLAIMED <b>28 SEPTEMBER 1999</b>	
TITLE OF INVENTION <b>SILENCER</b>					
APPLICANT(S) FOR DO/EO/US <b>Udo GÄRTNER and Dr. Anton WOLF</b>					
<p>Applicants herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:</p> <ol style="list-style-type: none"> <li>1.   <input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li>2.   <input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li>3.   <input checked="" type="checkbox"/> This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.   <input checked="" type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).</li> <li>5.   <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2))               <ol style="list-style-type: none"> <li>a.   <input checked="" type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau).</li> <li>b.   <input type="checkbox"/> has been communicated by the International Bureau.</li> <li>c.   <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).</li> </ol> </li> <li>6.   <input checked="" type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).               <ol style="list-style-type: none"> <li>a.   <input checked="" type="checkbox"/> is attached hereto.</li> <li>b.   <input type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4).</li> </ol> </li> <li>7.   <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))               <ol style="list-style-type: none"> <li>a.   <input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau).</li> <li>b.   <input type="checkbox"/> have been communicated by the International Bureau.</li> <li>c.   <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</li> <li>d.   <input checked="" type="checkbox"/> have not been made and will not be made.</li> </ol> </li> <li>8.   <input type="checkbox"/> A English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</li> <li>9.   <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</li> <li>10. <input type="checkbox"/> An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</li> </ol> <p><b>Items 11 to 20 below concern document(s) or information included:</b></p> <ol style="list-style-type: none"> <li>11. <input type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.</li> <li>12. <input checked="" type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.</li> <li>13. <input type="checkbox"/> A FIRST preliminary amendment.</li> <li>14. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment.</li> <li>15. <input type="checkbox"/> A substitute specification.</li> <li>16. <input type="checkbox"/> A change of power of attorney and/or address letter.</li> <li>17. <input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.</li> <li>18. <input type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154(d)(4).</li> <li>19. <input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).</li> <li>20. <input checked="" type="checkbox"/> Other items or information:</li> </ol>					
<div style="display: flex; justify-content: space-between;"> <div> <p>Form PCT/IPEA/416, 409, Form PCT/ISA/210</p> </div> <div style="text-align: right;"> <p><b>EXPRESS MAIL</b></p> <p>Mailing Label Number:   <b>EV073700511US</b></p> <p>Date of Deposit:        <b>March 27, 2002</b></p> <p>I hereby certify that this paper or fee is being deposited with the United States Postal Service</p> <p>"Express Mail Post Office to Addressee" Service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents and Trademarks, Box PCT Washington, DC 20231.</p> <p><i>Edward Nay</i> (Typed or printed name of person mailing paper or fee)</p> <p><i>[Signature]</i> (Signature of person mailing paper or fee)</p> </div> </div>					

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1/pats  
SILENCER  
DESCRIPTION

The inventor has at his disposal essentially three different silencer types for muffling exhaust noises of internal combustion engines, especially of motor vehicle drives. Each type, namely Helmholtz resonators, dissipation silencers and absorption silencers, functions according to different physical principles.

A three-pipe exhaust silencer is known from the journal *Automotive Engineering*, June 1977, page 45, Figure 5, with relevant text from page 44, middle column, paragraph 2 to page 45, left column, paragraph 1. In this silencer three tracking (axle-parallel) gas-conducting pipe sections are aligned in a silencer housing in such a manner that they run through an axial sequence of two silencer housing chambers, each isolated gastight from the other. Each of the three pipe sections is equipped with openings into their respective silencer housing chambers.

The first, intake-side pipe section, oriented in the flow direction of the gas, is closed at the far end and provided with openings in front of this end area through which the exhaust can enter in a dissipative manner into a first silencer chamber, routed approximately at a right angle.

A second pipe section of the silencer, closed at both ends, opens into this first silencer chamber via a corresponding pipe wall perforation. The exhaust entering into the first silencer chamber enters through means of the perforation of the second pipe, again dissipatively and at a right-angle routing into the second pipe neck. Due to the two-time right-angle routing of the gas flow this now runs axially counter to the direction of the entering exhaust stream at the intake neck.

The exhaust, again routed at a right angle, enters dissipatively into a second silencer housing chamber at the exit section of the second pipe section, which is situated at the entry side of the silencer and is axially closed.

The entry section of the third pipe section, which is also closed at the ends, opens into this second housing chamber next to the end section of the second pipe section. The entry section of the third pipe section also has corresponding openings for gas entry. The exhaust, once again routed at a right angle and dissipatively, then leaves the silencer via a non-perforated exit section of the third pipe section.

The exhaust, thus conducted over an s-shaped route via three separate pipe sections through the exhaust silencer, is thus altogether dissipatively dampened by means of a 360-degree diversion.

This series of dissipative gas flow routings, however, means not only significant streaming losses in the exhaust flow but also the unavoidable appearance of overtone resonances (page 44, Fig. 3, upper curve).

For targeted filtering of such narrow interference frequency ranges the intake section of the third pipe section of the exhaust silencer known in the state of the art technology as shown in Fig. 4 on page 45 is configured as a Helmholtz resonator and tuned to the corresponding narrow interference bands. The intake section of the third pipe section of the known silencer thus functions together with the perforated exit of the second pipe section bifunctionally, namely as a dissipative reflection sound silencer as well as a Helmholtz resonator.

Constructions of this and of a similar nature work with flow losses in the exhaust stream and thus also with performance losses in the drive train. These losses may not be too significant for the V8 motor given in the state of the art example, but they are not, for example, compatible

with a 3-liter vehicle. They also evidence only moderately effective broadband dampening. Moreover, more pre- or post-inserted resonators are required for further resonance interferences, in order to effectively dampen all interference noises of a motor vehicle exhaust.

Proceeding from this state of the art, the invention is called upon to create broadband, specifically tunable silencers, especially for automotive technology, which in their improved sound dampening effectiveness do not practically diminish the performance of the aggregate drive and which can be very compact in size.

The invention solves this problem by means of an exhaust silencer which has the features named in Patent Claim 1.

Specifically, the exhaust silencer with the characteristics of the invention excels above all in the combination of two characteristics, namely in its design as a pure Helmholtz resonator with a series of more or less narrow and from chamber to chamber overlapping silencing frequency bands, which in fine-tuning also are accessible to an acoustic design, and on the other hand by a configuration of the gas-conducting exhaust pipe in the silencer housing in such a manner that it is led through each resonator chamber of the silencer housing at least twice, in some instances even thrice, without interruption and to the greatest extent possible without dissipation and without producing noticeable streaming losses in the exhaust flow. The curved pieces, designed with the largest possible radius and preferably running through the end of the last silencer chamber of the axial series of chambers, are to be considered equivalent to such a two- or three-time pass of the exhaust pipe through the chamber.

A significant increase in silencer performance is achieved by means of the running through of one and the same resonator chamber with identically tuned openings specifications of one and the same continuous exhaust conduit, without requiring either a second separate silencer

in series or parallel, or that the axial construction length of the silencer housing surrounding the chamber needs to be increased.

The sum of the advantages gained in this manner with the exhaust silencer according to the invention allows this silencer to offer the best characteristics, especially for the construction of terminal silencers.

In this construction the clear trend toward modularization in automotive construction can be joined, since the exhaust-conducting hole pipes of the Helmholtz resonator can be configured as modular parts, especially of die cast aluminum or plastic, of identical modular configuration with openings specifications variably tuned to the volumes required by the identical chamber configurations. This makes possible the flexible production of identical terminal silencers which can be tuned, for example, to various drives.

The invention is described in more detail below on the basis of a construction model in connection with the drawings.

Figure 1 shows a schematic representation of a section according to I-I in Figure 2; and

Figure 2 shows a section according to II-II in Figure 1.

The exhaust silencer shown in Figures 1 and 2 with the characteristics of the invention is comprised of a silencer housing 1, in which a U-shaped exhaust-conducting pipe 2 is placed centrally. The cross-section of pipe 2 is also shown ovally flattened, whereby the long axes of the cross-section of the housing 1 and of the cross-section of the pipe 2 are arranged coaxially to each other. At its intake end 3 the pipe 2 has an intake connector neck (not shown), on its exit end 4 an exit neck (not shown) for the exhaust flow through pipe 2.

Pipe 2 is provided with a number of openings 5, indicated only schematically in Figure 1.

The silencer housing 1 is subdivided into an axial series of silencer housing chambers 6, which are hermetically gastight separated from each other and from which each one relative to the others evidences a differing resonance volume. An axial shortening of the housing dimension is achieved by means of the radial two-level configuration of the silencer housing 1; the shortening is especially noticeable for the greater chamber volumes.

The openings 5 in the gas-conducting pipe 2 are so arranged that they open only into one chamber 6, thus do not bridge two contiguous chambers. In each of the individual chambers 6, communicating openings of the same specifications open into the interior of the gas-conducting pipe. The openings however are configured on the respectively axle-parallel [tracking] legs of the U-shaped pipe. This is however not true for the uppermost silencer housing chamber 6' with the greatest chamber volume shown in Figure 1, but is well-compensated by means of the relatively long curved piece and the dampening of the simultaneously deepest dampened frequencies in this range.

On the whole a nearly doubled silencing effect is achieved by means of the similarly doubled silencing surface in the silencing overall cross section, without the need for the silencer housing to be oversized.

In the manner evident from Figure 1, the gas-conducting pipe in the construction example shown here is U-shaped so that the intake side 3 and the exit side 4 of the exhaust silencer lie next to each other on an axial side of the exhaust silencer. According to a further form of the invention a further bend can be attached instead of the exit connection 4, which in a third run, for example above or below the cut level I-I in Figure 2 leads to the opposite deep-tone end of the

silencer housing and there provides an exit connection, so that intake 3 and exit 4' lie across from each other in the same flow direction to both ends of the exhaust silencer.

Both forms of the invention, the U-shaped pipe configuration as well as the S-shaped pipe configuration have in common that they evidence no manner of fittings, baffles, or abrupt flow direction changes, and in this manner lead only to minimal flow losses in the exhaust stream. This means that there are no noteworthy losses in motor performance, even given the unusually good and precise effectiveness, tunability and performance capability of the silencer according to the invention.

A further advantage of this arrangement is that in an extremely broad frequency band, due to the high number of individual silencer chambers in the silencer housing, a selective dampening of the exhaust noise can be undertaken according to the acoustical design with the most simple means, namely an adaptation of the openings characteristics in the exhaust pipe, i.e., an adaptation of cross-section and wall height.

The summary included with the description is a component of this disclosure.



**CLAIMS**

1. Exhaust silencer, comprised of gas conducting pipe having openings of a defined cross-section and defined wall height, arranged in a silencer housing in such a manner that it runs through an axial series of silencer housing chambers insulated gastight from each other, into which the openings of the gas-conducting pipe communicatively open, characterized by  
  
a tuning of the volume of all chambers (6) of the silencer housing (1) in combination with the defined openings specifications of all openings (5) of the respectively communicatively arranged openings of a gas-conducting pipe (2) of a silencer housing chamber (6) to an interference frequency band from the noise spectrum of the exhaust gases respectively to be dampened, and by such a course of the pipe (2) through the silencer housing chambers (6) that it runs through each of the silencer housing chambers at least twice, with minimal dissipation losses.
2. Exhaust silencer according to Claim 1, characterized by  
  
a U-shaped configuration (3, 4) of the pipe conduit in the silencer housing (1).
3. Exhaust silencer according to Claim 1 characterized by  
  
an S-shaped configuration (3, 4') of the pipe conduit in the silencer housing (1).
4. Exhaust silencer according to one of the Claims 1 through 3, characterized by

a gas-conducting pipe (2) of die cast aluminum or plastic.

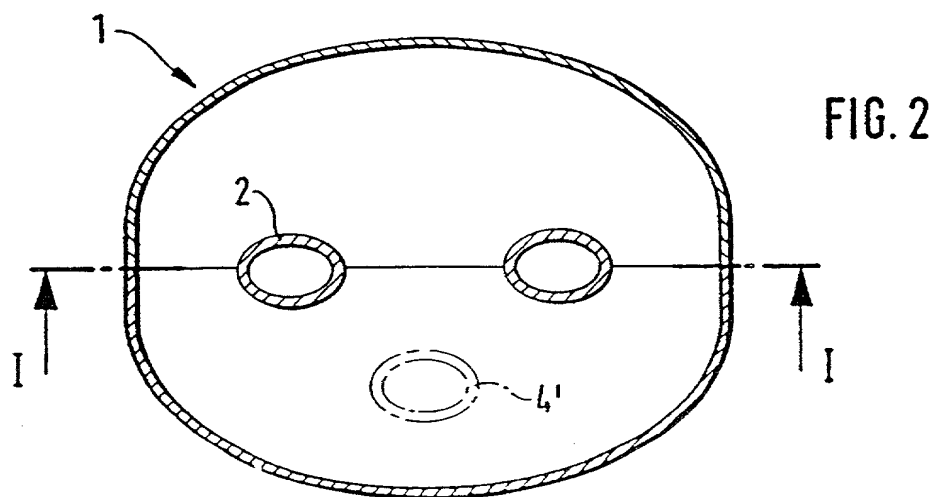
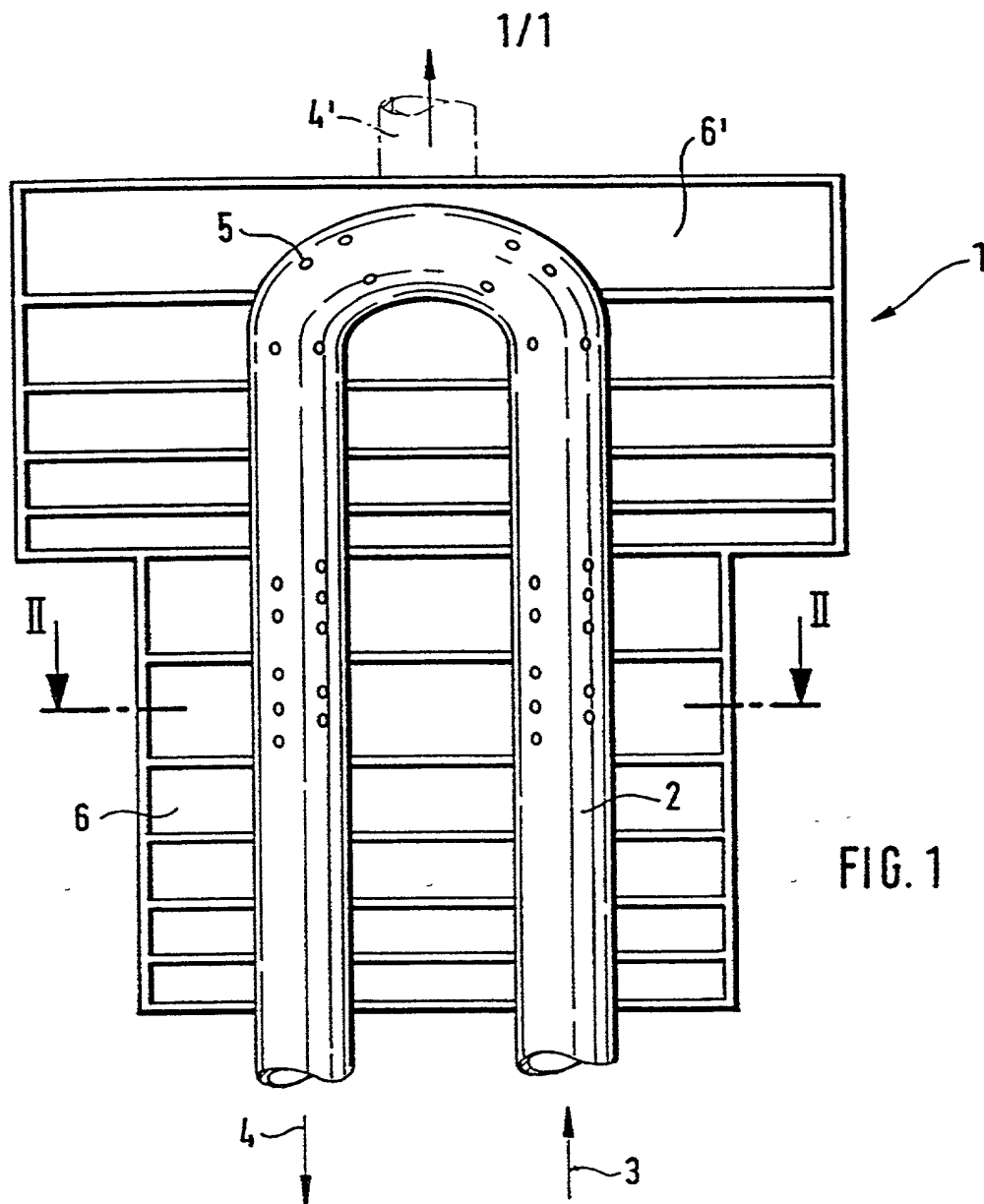
5. Exhaust silencer according to one of the Claims 1 through 4,  
characterized by  
a configuration of the gas-conducting pipe (2) as a modular part for a silencer housing (1)  
configured in two parts.

6. Exhaust silencer according to Claim 5,  
characterized by  
a configuration of the gas-conducting pipe (2) as part of a modular series of modular parts with  
openings specifications which vary from each other in their dimensions and which are tuned to  
the same respective silencer housing chamber volumes, but respectively varying openings  
characteristics for respectively equal silencer housing chamber volumes.

7. Use of the exhaust silencer with features according to one of the Claims 1 through 6 as a  
terminal silencer in exhaust installations of passenger vehicles.

ABSTRACT

The invention relates to a silencer which is designed, in particular, to be suitable as a terminal silencer. Said silencer is configured as a simple Helmholtz resonator and is characterized in that it has excellent silencing properties provided by a compact construction, it can be constructed in a modular manner and that the acoustic design for silencing the exhaust noise can be fine-tuned. To this end, the pipe (2) that conveys the exhaust gas, which runs continuously through the silencer housing (1), the latter containing several chambers (6), remains practically devoid of dissipation in at least two, preferably three pipe runs with large curvature radii, even in the transition section of the runs. In addition, a high degree of silencing is achieved by the effective cross-sections of the resonance cavities, which are identical for each chamber, whereby said cavities open into each chamber from two or three pipe runs.



DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY  
(includes reference to PCT International Applications)

FROMMER LAWRENCE & HAUG LLP  
File No.: 540608-2002

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first and joint inventor (if plural, names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention ENTITLED:

SILENCER

the specification of which:

- ☒ is attached hereto  
☐ was filed on as: \_\_\_\_\_  
☐ United States Application Serial No. \_\_\_\_\_  
☒ PCT Application No. EP00/09529, filed September 28, 2000 and published on April 15, 2001 as WO 01/23714  
☐ with amendments through date even herewith (if applicable, give details).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code § 119 (a) - (d) or § 365 (b) of any foreign application(s) for patent or inventor's certificate, or § 365 (a) of any PCT International application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application for patent or inventor's certificate or any PCT International applications designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) on which priority is claimed:

Prior Foreign/PCT Application(s) [list additional applications on separate page]:

Country (or PCT)	Application Number	Filed (Day/Month/Year)	Priority Claimed:
			Yes No
Germany	19948146.6	September 28, 1999	X

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below.

(Application Number) (Filing Date)

I hereby claim the benefit under Title 35, United States Code § 120 of any United States application(s) or § 365 (c) of any PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior United States or PCT International application(s) in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

FROMMER LAWRENCE & HAUG LLP

File No.: 540608-2002

Prior U.S. (or U.S.-designating PCT) Application(s) [list additional applications on separate page]:

U.S. Serial No.:      Filed (Day/Month/Year)      PCT Application No.      Status (patented, pending, abandoned)

28 September 2000      PCT/EP00/09529      pending

I hereby appoint John R. Lane, Esq., Registration No. 35,582, Mark W. Russell, Esq., Registration No. 37,514 and FROMMER LAWRENCE & HAUG LLP or their duly appointed associates, my attorneys or agents, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to file continuation and divisional applications thereof, to receive the Patent, and to transact all business in the Patent and Trademark Office and in the Courts in connection therewith, and to insert the Serial Number of the application in the space provided above, and specify that all communications about the application are to be directed to the following correspondence address:

John R. Lane, Esq.  
c/o FROMMER LAWRENCE & HAUG LLP  
745 Fifth Avenue  
New York, NY 10151  
FAX (212) 588-0500

Direct all telephone calls to: (212) 588-0800  
to the attention of:  
John R. Lane

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

INVENTOR(S):

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Full name of sole inventor: Udo Gärtner  
Residence: Langenselbolder Weg 18, 63607 Wächtersbach  
Citizenship: German

Signature:  Date: 03/21/2002

Full name of 2nd joint inventor: Dr. Anton Wolf  
Residence: Am Schnepfenrain 13a, 63571 Gelnhausen  
Citizenship: German

Post Office Addresses of inventors: Same as residence addresses.

NOTE: In order to qualify for reduced fees available to Small Entities, each inventor and any other individual or entity having rights to the invention must also sign an appropriate separate "Verified Statement (Declaration) Claiming [or Supporting a Claim by Another for] Small Entity Status" form [e.g. for Independent Inventor, Small Business Concern, Nonprofit Organization, Individual Non-Inventor].

**DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY**  
(Includes reference to PCT International Applications)

**FROMMER LAWRENCE & HAUG LLP**  
File No.: 540603-2002

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first and joint inventor (if plural, names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention **ENTITLED:**

**SILENCER**

the specification of which:

- ☒ is attached hereto  
☐ was filed on as: \_\_\_\_\_  
☐ United States Application Serial No. \_\_\_\_\_  
☒ PCT Application No. EP00/09529, filed September 28, 2000 and published on April 15, 2001 as WO 01/23714  
☐ with amendments through date given herewith (if applicable, give details).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

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Prior Foreign/PCT Application(s) (list additional applications on separate page):

Country (or PCT)	Application Number:	Filed (Day/Month/Year)	Priority Claimed:
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(Application Number)	(Filing Date)
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FROMMER LAWRENCE & HAUG LLP  
File No.: 540608-2002

Prior U.S. (or U.S.-designating PCT) Application(s) (list additional applications on separate page):  
U.S. Serial No.: Filed (Day/Month/Year) PCT Application No. Status (patented, pending, abandoned)  
28 September 2000 PCT/EP00/09529 pending

I hereby appoint John R. Lane, Esq., Registration No. 35,582, Mark W. Russell, Esq., Registration No. 57,514 and FROMMER LAWRENCE & HAUG LLP or their duly appointed associates, my attorneys or agents, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to file continuation and divisional applications thereof, to receive the Patent, and to transact all business in the Patent and Trademark Office and in the Courts in connection therewith, and to insert the Serial Number of the application in the space provided above, and specify that all communications about the application are to be directed to the following correspondence address:

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FAX (212) 588-0500

Direct all telephone calls to: (212) 588-0500  
to the attention of:  
John R. Lane

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

INVENTOR(S):

Signature: Udo Gartner Date: 03/20/02

Full name of sole inventor: Udo Gartner  
Residence: Langenselbolden Weg 18, 63607 Wächtersbach  
Citizenship: German

Signature: Dr. Anton Wolf Date: \_\_\_\_\_

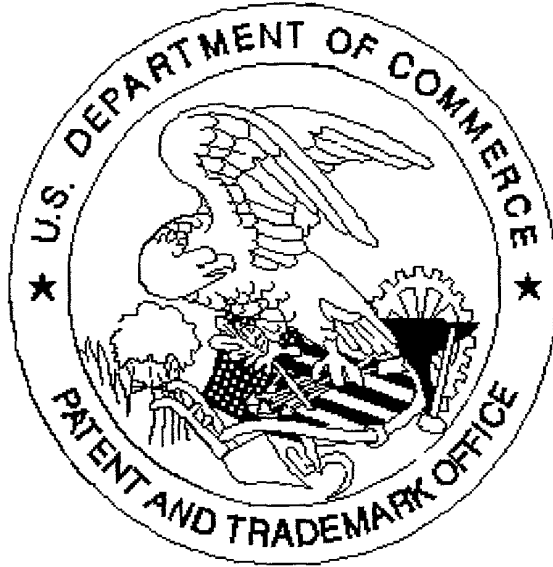
Full name of 2nd joint inventor: Dr. Anton Wolf  
Residence: Am Schnepfenrain 13a, 63571 Gelnhausen  
Citizenship: German

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Pages 3 and 4 of Declaration.*